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EDITOR'S NOTES

Report of Supreme Officers did not reach the Editor's office in time for publication in this issue.

Study carefully Dr. Watts' Paper in this issue—it will be time well invested.

Branch Presidents will do well to follow the lead of Chicago—start now to plan and save for Providence in 1923.

MONTHLY REVIEW

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EDITORIAL

ESSENTIALS TO PROGRESS

The American Electro-Platers' Society has but one aim and purpose, or reason for its existence, i. e., the advancement of knowledge in the science of electro-plating and finishing of metals. If the Society functions as it should, and as we all desire to see it, its activities must result in progress in the art and science of electro-depositing and finishing of metals. There are at least two definite things to be done to insure progress.

First, We must give wider circulation to known methods and laws that govern the successful cleaning, plating and coloring of our product.

Second, Through study, experiment and scientific research, we must discover and develop more efficient methods and in some cases entirely new methods of producing electrolitic deposit.

In this editorial we will draw attention to the essentials to progress as they apply to the item first mentioned above.

It is the history in the development of the race that when man had a job too big for himself alone, he learned that the thing he could not do was made possible through organization and co-operation with others, and it is to this end that the A. E. S. is organized. Since no one man can, in the short span of his existence, master all the different branches of this specific science, yet if the experiences of a group are recorded and circulated, knowledge of the science is advanced—in that the experience of many (one thousand in the case of A. E. S.) can become the basis of knowledge to each individual. Therefore, to function as we should and make progress, it is essential that our membership shall increase, and that a greater number of our

membership shall record their experience for the benefit of all.

Use the REVIEW. That is what the REVIEW is for. Let others know the methods or process that has brought success to you in your special field, thus advance the science of electro-plating. Let it be known that we are out for 100 per cent. of the men and women who by reason of their experience and activity in electro-plating are eligible for membership in the A. E. S. The A. E. S. needs them and they need the A. E. S. still more.

RELATIONS OF ANODE AND CATHODE EFFICIENCIES

By Oliver P. Watts

Assoc. Prof. of Chemical Engineering, University of Wisconsin

In plating solutions anodes have two distinct functions to perform: First, to distribute the current properly and uniformly to the objects which are being plated; and, second, to supply metal to the solution at exactly the same rate as it is being deposited. It is only with the second of these functions that this paper is concerned.

With the long experience of the past to draw on, it is a comparatively easy matter to make up a solution that will at the outset give a good deposit of any particular metal. The difficulty is to maintain the solution in such condition that it will continue to yield the same good deposit every day during months and years of use.

There are several influences at work which cause the composition of a plating bath to change with use. One is the drip from the work as it is removed from the solution. Where a bath is used to capacity every day the quantity of chemicals carried away on the objects plated is sufficient to weaken the bath materially ,and if these are not replaced from time to time, the solution will finally become so weak that the current density regularly used will cause a "burned" deposit. It should be noted that "drip" does not change the relative proportions of chemicals in the solution, but lowers the concentration of all of them by the same amount. In cyanide solutions the carbon dioxide of the air reacts slowly with cyanide and makes it necessary to add this chemical occasionally in order to maintain the original amount of free cyanide. Certain plating solutions

give a better deposit if acidified to a particular degree; for example, the sulphates of zinc and copper. This acid reacts with the anodes dissolving metal from them, slowly in the case of copper, but rather rapidly with zinc, thus lowering the acidity and raising the metal content of the solution. The desired acid content can be restored by adding more acid, but the extra metal remains.

Before entering upon a detailed consideration of current efficiencies at the electrodes it may be well to define the term **current efficiency.** Farady's law states that the amount of chemical change which takes place at both anode and cathode is proportional to the strength of current, to the time, and to the chemical equivalent of the metal or other element concerned, 26.8 ampere hours being required to deposit at a cathode or to dissolve from an anode a gram-equivalent of any substance. (The gram-equivalent is that number of grams which is equal to the quotient of the atomic weight of an element divided by its valence. Tables of atomic weights and valences are usually given in text books on chemistry.) Faraday's law expresses the facts as found by hundreds of experiments, and one can no more expect to find exceptions to it than to the law of gravitation. When someone shows us a heavy body suspended in air without any visible means of support, we do not enthusiastically acknowledge his claim that he has discovered a means of preventing the action of gravitation, but we look for, and **always find,** the suspending wire, thread, or magnetic force, which is opposing gravity and preventing its pulling the object to the earth. So when someone, with more enthusiasm than judgment, announces that he has overcome Faraday's law, careful investigation will show that he has overlooked chemical corrosion, some other change produced in the electrolyte, or the simultaneous deposition of another element along with the metal which he is trying to deposit from the solution.

Faraday's law does not state that one gram-equivalent of metal is deposited for every 26.8 ampere hours that pass through an electrolyte, but only that there is a total chemical change equal to one gram-equivalent at both anode and cathode. It is left for us to find out in each case whether it is one, or several different actions, that make up this total.

To illustrate: The atomic weight of iron is 56, and its valence in a solution of ferrous sulphate is 2, so the chemical equivalent of iron when plated out of a solution of ferrous sulphate is 28. On passing current through this solution it will be found that 26.8 ampere-hours deposit 28 grams of iron at the cathode and dissolves the same amount from anodes of pure iron. If we now add 20 c. c. of concentrated sulphuric acid to each liter of solution and pass the same amount of current, the result will be quite different. The increase in weight of the cathode will be perhaps only 18 grams, and the anode may have lost 30 grams. It looks at first sight as if Faraday's law no longer applied but let us look carefully! Suppose that we took three hours for electrolysis in the last case—we will let the cathode and anode hang in the solution another three hours with no current passing. A steady evolution of gas from each electrode tells us that some chemical change is taking place, and on weighing the electrodes again we find that each has lost 3 grams. This explains the loss of 31 grams by the anode during electrolysis—the current dissolved 28 grams, as Faraday's law predicted, and attack by the acid took away the other 3 grams. But what about the cathode, at which there was a deficit of 10 grams of iron? Had we watched the electrodes during the second electrolysis we would have seen a gas, hydrogen, coming from each electrode, and had the gas been collected it would have been found that 0.1 gram, the equivalent chemically of three grams of iron, was evolved from the anode, and 0.35 grams, equivalent to 10 grams of iron, at the cathode. The total action at each electrode is the same, and is that called for by Faraday's law. The dissolving of iron from the anode was 28 grams by the current and 3 grams by the acid. At the cathode we might have expected the deposit of 28 grams, but instead get 18 grams of iron, and hydrogen equivalent to 10 grams of iron.

Of the above hydrogen we know that .1 gram was set free by attack of the deposited iron by the acid, but how did we get the remaining 0.25 gram of hydrogen? This was deposited directly by the current. It is not at all uncommon to find hydrogen thus directly deposited along with a metal from plating solutions. This happens regu-

larly in the cyanide copper solution and in brass plating baths, and in every case the total weight of metal plus hydrogen equals the amount of action called for by Faraday's law.

But the hydrogen or other gas liberated at the electrodes has no value to the plater, hence we reckon the efficiency of deposition or of solution on the per cent. of the current that is usefully employed in dissolving or depositing metal. If nothing but the metal desired is deposited at a cathode, and none of this is redissolved by acid, free cyanide, or other corroding agent, the amount of metal will equal that calculated from Faraday's law, and we say the current efficiency is 100 per cent. To find the efficiency of deposition or of anode corrosion, we have only to weigh the electrodes, electrolyze, keeping a careful record of time and current with instruments of guaranteed accuracy, and then weigh the electrodes again. If we divide the change in weight by the amount calculated for the number of ampere-hours used, the quotient will be the current efficiency.

We have seen how anode efficiency may exceed 100 per cent. Had we used a platinum anode its weight would have remained unchanged, and the anode efficiency would have been zero. Anode efficiency may, then, vary from zero for an entirely insoluble anode, to considerably over 100 per cent. Except for platinum plating, zero anode efficiency rarely met with in plating solutions. Cathode efficiency usually lies between 100 and 50 per cent., although it may fall to zero when nothing but gas is deposited. Addition of a large excess of free cyanide to a copper solution, or of much sulphuric acid to a nickel bath, will cause efficiency at the cathode to drop to zero. This is the result of the deposition of hydrogen in place of the metal, and not of corrosion by the cyanide or by the acid of metal already deposited. Efficiency at the cathode may be less than 100 per cent., either by attack of the metal by some corrosive agent, or by a portion of the current being spent in depositing a gas or in producing some chemical change other than deposition of metal.

Current efficiency in plating solutions is the per cent. which the metal actually deposited or dissolved is of that calculated by Faraday's law, assuming that all the current is spent in depositing or dissolving metal.

Effect of Unequal Current Efficiencies

It is evident from the wide divergence in composition of the solutions in successful use for depositing any particular metal, that it is not necessary for good results that fixed amounts of the different chemicals be used, or that they be used in a definite proportion to each other. There are, however, limits within which the ingredients of a solution for depositing any metal under certain conditions should lie, and when a solution has been made up to work well for some particular class of plating, it is very desirable to keep its composition unchanged. In order to do this it is not necessary that the current efficiency at both anode and cathode be 100 per cent., but only that they be equal—when metal will be added at the anode as fast as it is removed at the cathode.

If cathode efficiency is greater than efficiency at the anode metal is being removed from the solution faster than it is supplied, the solution is becoming weaker in metal, and if this continues for any considerable time, the solution may become so impoverished in metal that "burning" of the deposit results. Besides lessening the metal content, this inequality of anode and cathode efficiencies causes an increase in the concentration of the acid whose salt constitutes the bath, or of free cyanide if it is a cyanide solution. If efficiency at the anode exceeds that at the cathode the solution tends to become alkaline, and its free acid or free cyanide, if it contains any, is lessened in amount by combining with the excess metal.

The effect of increase of acidity in plating solutions varies greatly according to the metal that is being deposited. It is well known that there is a preference for the deposition of one of two metals that may be in the same solution. For example, if 10 oz. of copper sulphate and the same quantity of zinc sulphate be dissolved in a gallon of water and current be passed through the solution, only copper is deposited. Similarly, if copper sulphate and hydrogen sulphate (sulphuric acid) be dissolved together, the preference is for the deposition of copper. A copper sulphate bath may therefore be acidified very strongly without much falling off in efficiency of deposition at the cathode. Even a slight addition of sulphuric acid to a

nickel solution causes a marked decrease of efficiency at the cathode, and a considerable addition causes the efficiency to drop to zero. When there is any choice offered for the deposition of either nickel or hydrogen the preference is to deposit hydrogen; therefore it requires the presence of but a small amount of a strong acid, like sulphuric or hydrochloric, to cause most of the current to be spent in depositing hydrogen instead of nickel.

It is only hydrogen in the ionic state that can be deposited instead of a metal. The general difference between a strong and a weak acid is that the former is highly dissociated into ions, or ionized, while the weak acid is but slightly ionized when dissolved in water. The weaker the acid the more of it may be added without cutting down efficiency at the cathode. Considerable amounts of acetic acid, and any quantity of the extremely weak boric acid may be added to a nickel bath without materially lessening the efficiency of deposition.

It is the general experience that nickel deposited from a slightly acid solution is whiter than that deposited from a strictly neutral soltuion, but the plater who tries to secure this desirable whiteness by addition of a strong acid like sulphuric is likely frequently to add too much acid and cause a great falling off in efficiency at the cathode, and also to get a brittle deposit. The value of the much-used boric acid consists in its ability to impart a slight acidity to the solution without the possibility of harm by the addition of an overdose.

In cyanide solutions free cyanide acts on current efficiency at the cathode like free acid in ordinary salt solutions; with some metals there is a marked lessening of current efficiency as the quantity of free cyanide is increased, while with other metals large amounts of cyanide may be added without any serious loss in efficiency. It all depends on whether the preference **in cyanide solutions** is for the deposition of the particular metal or for hydrogen. With copper and zinc the preference is for hydrogen, and if a considerable excess of cyanide be added efficiency at the cathode is greatly lowered. It does not take a very great amount of free cyanide to reduce the efficiency to zero, i. e., to completely prevent the deposition of copper from a cold so-

lution. In the case of silver the preference is for deposition of metal, and large amounts of cyanide may be added without causing deposition of hydrogen at a current that did not cause its deposition before cyanide was added.

From a solution weak in metal a large current, i. e., too high a current density, will always cause deposition of hydrogen, and consequently a low current efficiency. It is important to keep this in mind, for, conversely, if it is desired to carry on deposition at a high rate metal must be supplied **at the cathode** as fast as needed by the high current. One way to assist in maintaining plenty of metal at the cathode is to use a solution which contains much metal at the outset, i. e., to employ a concentrated solution; another way is to heat the solution, thus increasing the rate of diffusion and at the same time setting up convection currents; a third and more effective way is to stir the solution vigorously. If the highest possible rate of deposition is desired all three methods should be combined by using a hot, concentrated solution which is vigorously stirred. By this combination the writer has made good nickel deposits at over 1800 amperes per square foot. The very general employment of "motion plating" for heavy silvering permits rapid deposition from baths too dilute to allow this without the aid of one of the three methods just mentioned for maintaining the supply of metal at the cathode. Predictions are unsafe things to indulge in, but the writer will venture one, viz.: that the day will come when, for some solutions at least, the plater will be using the methods of the electrolytic refiner, and will deposit his metal from a warm, highly concentrated solution, which is circulated and filtered continuously, and in which he will "go the refiner one better" by adding motion of the object being plated. Under these conditions plating will be done with a speed that now seems unbelievable, but which can be utilized only by some form of "mechanical plater" by which the time that each article is in the bath is fixed accurately.

Deposition of hydrogen along with some metals injures the quality of the deposit besides lessening its amount. This is the case with nickel, which absorbs some of the hydrogen, and is thereby rendered brittle and caused to curl from the

foundation on which it is plated. Where there is a strong preference for deposition of metal rather than for hydrogen, for example, from solutions of silver cyanide and copper sulphate, the appearance of hydrogen indicates that the current density used is too high for the metal concentration of the solution; as a result of the use of too high a current the deposit is "burned." Because burning is accompanied by evolution of hydrogen many platers hold the erroneous idea that hydrogen is the cause of the burning. A consideration of the cyanide copper and brass solutions, where hydrogen is always evolved along with the deposition of metal, shows this view to be incorrect.

Control of Current Efficiency

Most solutions tend to be self-regulating in the matter of current efficiency, for if anode efficiency is less than efficiency at the cathode free acid or cyanide is being formed, and accumulation of either of these reduces efficiency of deposition and increases efficiency of anode corrosion. It is evident that in time increase of acid or cyanide will render the efficiencies at anode and cathode equal, when the composition of the solution will cease to change. The trouble is that in many solutions before this state of stability has been arrived at, the large excess of acid or cyanide has lowered the efficiency of deposition to a degree that cannot be endured, or may have spoiled the character of the deposit. Many solutions cannot, therefore, be left to correct themselves, in respect to the relation between anode and cathode efficiencies.

There is a general principle which applies to efficiency at the anode in all solutions, viz.; that increase of current density at the anode tends to lower the current efficiency, and lowering of current density raises current efficiency, if this is not already 100 per cent. Because of desiring a particular current on the objects being plated, it is frequently not feasible to change the current flowing through the bath, and the change of current density desired must be sought through a change in extent of anode surface.

If it is found that a nickel bath loses the desirable faint acidity above mentioned, it is because the efficiency at the anode exceeds that at the cathode, and metal is being dissolved faster than deposited. The remedy is to raise the

current density at the anode, which can be done by removing a sufficient number of anodes. If, on the contrary, the nickel bath by use becomes too acid, the current efficiency at the anode is less than at the cathode, and the current density at the anode should be lowered by adding more anodes. The corrodibility of nickel anodes varies greatly, and it may happen that with all the anodes that the tank will hold there is still a production of acid; the remedy is to increase the corrosive power of the solution or to change to anodes which are more easily corroded. If the original solution contained only sulphates, its corrosive power may be increased by addition of a chloride; if this does not raise efficiency at the anode sufficiently other and more soluble anodes should be substituted. A temporary correction of acidity and restoration of the nickel content may be made by addition of nickel carbonate, but until the unequal efficiencies at the electrodes is corrected too great acidity will soon recur.

From the cyanide copper and brass solutions hydrogen is regularly deposited with the metal, indicating a current efficiency of deposition less than 100 per cent.; if current efficiency at the anode is greater than this, some of the necessary free cyanide is being used up, and the plater will soon be informed of this by the anodes becoming coated, and by the deposit becoming less bright. This condition may be remedied temporarily by adding more sodium cyanide. This increase of free cyanide raises the anode efficiency and acts still more powerfully in lowering efficiency at the cathode, both of which changes use up cyanide more rapidly than before, so it is only a short time before another dose of cyanide is needed. The proper relation between extent of anode and cathode surface is therefore very important in the brass or cyanide copper solution, but is difficult to secure, for too little anode surface causes the formation of a high-resistance film of metallic cyanide on the anodes. This is more troublesome in the brass than in the copper solution.

Since efficiency of deposition in the silver solution is affected but little by the amount of free cyanide present, this solution is very easy to regulate. The amount of free cyanide needed to give clean anode corrosion at any desired current density can be added without causing accumulation

of metal in the bath. The wide limits within which free cyanide and all other constituents as well may be varied without preventing satisfactory operations is shown by the analyses of silver baths recently published in the Trans. of the Faraday Society, vol. 16, p. 524-33. A few of these solutions have been in use for 50 years, and many of them for 30 years.

Summary

1. Increase of current density tends to lower efficiency at both electrodes, but the amount of lowering varies greatly with different solutions, being affected by the metal concerned and by the amount of free acid or cyanide in the solution.

2. Lowering current density tends to raise current efficiency at both electrodes, if this is already less than 100 per cent.

3. Increase of free acid or cyanide tends to raise efficiency at the anode and to lower efficiency at the cathode, the extent of change varying greatly with the metal concerned, particularly efficiency at the cathode. Anode efficiency may exceed 100 per cent.

4. Increase of temperature or stirring tends to raise current efficiency at both electrodes toward a maximum of 100 per cent.

5. There is a natural tendency toward equality of current efficiency at anode and cathode. When the cathode efficiency is the greater, free acid or cyanide is on the increase an dthis tends to a lowering of cathode and a raising of anode efficiency; when anode efficiency is the larger, free acid or cyanide is being removed and the metal content is increasing, which tend to lower efficiency at the anode and to raise efficiency at the cathode. In some solutions this equalization of efficiencies is so slow that it cannot be left to take care of itself, because a poor deposit will result before equilibrium is reached.

6. A high metal content in the bath permits use of a high current density without abnormal falling off in cathode efficiency.

7. Even though the efficiency at both anode and cathode were 100 per cent., a much-used bath would finally become

too weak for use if only water were added to make up for evaporation and for the solution carried out on the objects plated. Metallic salts must be added to make up the loss. When efficiency at the anode exceeds that at the cathode it is usually only necessary to add acid or sodium cyanide, for the extra metal needed to maintain the solution is taken from the anodes.

UDYLITE PROCESS

In the June issue of the REVIEW, the organ of the American Electro-Platers' Society, there appears in article by Mr. C. H. Proctor on "Electrodeposition of Cadmium versus Zinc." In it he reviews to some considerable extent the causes of iron rusting and then goes on to describe the various methods which have been and are now employed to rust proof iron or steel articles.

After passing over galzanizing, electro-galvanizing and Sherardizing, which are known, and of great worth in the commercial world, he refers to other methods which are less known and employed. Some of these, which do not demand the deposit of a metal upon the surface of the iron or steel article to be rust proofed are in use today, the most common being the Parker Process, which consists in processing steel articles so that various phosphates, including that of iron, are made part of the surface of the article being treated. All of the mentioned methods in his paper have their part in industry and have various values for the exposure they undergo.

Just a year ago today three patents were granted to the Udylite Process Company for a rust proofing process which differed from these previously mentioned. The principle of this process was the depositing electrolytically of metallic Cadmium and an after baking or heating step. This causes the penetration and alloying of some of this metallic Cadmium which forms a thin skin underneath the top surface of the Cadmium and is integral with the skin and the base metal. As Mr. Proctor points out, these are apparently specific patents, and mentions particularly the use of these processes for protecting edged tools, springs, and piano wire. The patentees and the company to which they were assigned were fully aware that Cadmium plating had been

done before. Naturally searches in the literature were made both by them and by the Patent Office, and yet the Patent Office granted these patents after consideration of the literature and past practice. Apparently, the Patent Office was satisfied that something unique was offered in these patent applications or else they would not have granted patents. In the literature mention is made of the specific references which Mr. Proctor gives in his article and indeed he could have elaborated very considerably had he cared to do so in writing up his article. The fact, however, remains that previous work in this field was apparently incomplete and not commercial, as there was nowhere commercial work being done with Cadmium previous to the putting out of the process by the Udylite Company.

A very complete review and a history of the work on Cadmium plating can be found in a paper presented to the 25th general meeting of the Electro Chemical Society in New York City, April 18, 1914, which is entitled "Electrodeposition of Cadmium." Part one is the review, part two is the experimental section. This was given by Frank C. Mathers and Hugh M. Marble. This is much more comprehensive than the references Mr. Proctor has cited.

The fundamental difference between the small scale on which this original historical work was done and the various kinds of coats obtained, is that no one had previously plated workable coats of Cadmium on a large scale and afterwards so treated them as to change the properties of such coat chemically and physically, while it was still a part of the article so coated.

Mr. Proctor has gone to some trouble to tell of the working of the Udylite Process, but has not taken the trouble in so doing to check his figures and data. Under such circumstances his article can not be taken seriously.

In his mention of these patents he says: "The specific patent is based upon the assumption that when the **Steel Coated Cadmium** is heated to approximately 322°C the Cadmium penetrates the steel . . ." Nowhere in the patents is mention made of this temperature 322°C, which happens to be one degree higher than the melting point of Cadmium. If steel articles so treated are heated to this temperature in fairly close ovens the Cadmium commences to fuse and tends to form droplets of Metallic

Cadmium on the surface of the article. Heating to this temperature entirely destroys the surface of the article and therefore spoilts it, as far as its commercial appearance is concerned. The patents actually state that articles are heated to 150 to 200°C, but they may be heated to 250°C if immersed in quick lime. This is error number one and we do not know whether it has been placed in his article by mistake or through carelessness.

In case the value of the baking step of the Cadmium coated steel seems impossible or surprising to Mr. Proctor, we would ask him to look in "Galvanizing and Tinning," by W. T. Flanders, page 270. He will note therein a curve and comments which tell of the rate of absorption of zinc vapor at temperatures between 325° and 375°C, which is much below the melting point of zinc. We also wish to refer him to the Dewey Patent, which parallels the baking of Cadmium coated articles by baking zinc plated articles or zinc coated articles in a manner different from Sherardizing and with a different range of temperature. Furthermore, we can, if he wishes, prove by chemical, microscopic, and physical means that penetration of Cadmium into the iron and alloying therewith does occur.

He next gives a formula as apparently shown by the Udylite Process in its patents, which reads:

Water	1 gallon
Sodium Cyanide	6½ ounces
Cadmium Hydrate	4 ounces
Sodium Hydrate	1 ounce

An actual check by inspecting the patents indicates that his reading of the formula is incorrect. It is true he has said this is the formula substantially, but it is not even substantially so. The actual formula mentioned in the patent when transposed from metric measurements to avoirdupois is:

Water	1 gallon
Sodium Cyanide	5.8 ounces
Cadmium Hydrate	4.35 ounces

and no mention is made of sodium hydrate. Sodium hydrate, however, is formed in the preparation of the solution, but instead of one ounce, which Mr. Proctor mentions in his conception of this formula, the amount contained therein is 2.37 ounces. This is misstatement No. 2.

Probably the formula given by Mr. Proctor was given roughly, but in any case it is not as shown in the patents he cited.

He next goes on to describe in a little example the comparative cost of Cadmium and zinc plating on Ford rims. Naturally, in the end of it he deduces an answer quite unfavorable to Cadmium, but if his example is examined it is found that the data as shown is incomplete and we would like to comment upon this particular example that he chooses.

The relative cost of zinc and Cadmium, besides depending upon some of the factors he gives, also depends upon the thickness of metal deposited. Mr. Proctor has not mentioned the relation between the thickness of the two metal coats on these rims and we would like to ask him whether he assumed they would be of equal thickness. Our understanding is that the thickness of deposit of zinc on tire rims varies from .0004" to .001", whilst the standard thickness of Cadmium is from .00015" to .0002". He makes mention also in his calculation that the current consumption for zinc and Cadmium would be the same. This is not true. One ampere will deposit 2.09 grams of Cadmium per hour from a Cadmium solution with an efficiency of 100 per cent. and from a zinc solution, the same current, at 100 per cent. efficiency, one ampere for one hour, will deposit only 1.229 grams. There is an allowance to be made in the calculation for the difference in the specific gravity of the two metals, zinc being 7.15—Cadmium 8.64. In addition to this, as the coat of Cadmium is from one-half to one-fifth the thickness of zinc the actual current required by a given number of rims would be less. Therefore, the current item for Cadmium will be lower than for zinc.

Another point in favor of the Cadmium plating is the quicker time of plating, owing to the high current density employed. This would mean increased output per unit equipment and decreased floor space. These have their values which should have been shown in Mr. Proctor's example.

Another thing Mr. Proctor reads from the copies of the Udylite patents that he has is the fact that insoluble anodes of Cadmium are used. He notes their use and states that if Cadmium metal anodes were employed that a lower cost

for Cadmium deposited would result. If any member will take the trouble to examine the copies of the Udylite Patents No. 1383174, 1383175, and 1383176, he will finr that in these patents no mention is made of insoluble anodes at all. In fact, it is specifically stated in each case that the anodes are metallic Cadmium. It is true that the Uydlite Process has been put to various uses with insoluble anodes and proper protection has been obtained for the use of these in the various patent applications which are now pending. This has been done after considerable experimental work, which has indicated that the insoluble anodes are very much more preferable to the metallic Cadmium anodes. This is due to the fact that the Cadmium anodes in the solutions, containing no free cyanide, films over and the current passed through the bath drops off rapidly. We cannot understand what Mr. Proctor means by the false impression gained "that insoluble anodes could be used entirely with the Udylite Process," and that this is the factor which has appealed to many firms, etc. Insoluble anodes are being used because they work better, because, in fact, they are absolutely essential to obtain even plating conditions in these baths.

He also states that they, the industrial concerns, also subscribe to the idea that Udylite solutions would never have to be replaced. He certainly did not read this statement in the patents and no statement to this effect has been made elsewher. He has, therefore, coined phrases, put them into the mouth of the Udylite Process Company and used them for his benefit. No statement has ever been made that the Udylite Process would do or was intended to completely supercede the other rust proof methods that are now being employed. In many places it can replace some of the previous methods as the finishes obtained by it not only have high rust proof values, but give beautiful results in many cases where the others do not.

The value of the Udylite Process is a question of comparison with other methods under outside conditions. Comparisons have been made very throughly on commercial finished articles finished by the other methods and the knowledge gained has indicated that the Cadmium plated baked articles in many cases far surpass some of the previous methods.

It would be well before closing to comment upon Mr. Proctor's attitude in writing this paper. He apparently has done it with some heat and at the same time has been careless of his data. We may make mention that he even gives the numbers of the patents granted to the company wrongly, though this, of course, may be a typographical error. His sarcastic comments are quite out of place and not worthy of consideration.

It would seem that before writing an article of this kind he should at least be sure of his facts and figures, or take the chances of having his statements branded as absurd and his future articles looked upon with a reasonable doubt by all clear-thinking readers.

Yours very truly,

UDYLITE PROCESS COMPANY.

Per C. H. HUMPHRIES,

Member Indianapolis Branch A. E. S.

CONVENTION REPORT

This Report of Mr. A. G. Reeve to his branch will be of interest to the members who were unable to attend the Cincinnati Convention

The Cincinnati Convention was a very interesting and profitable one. The visit and inspection of the National Cash Register plant was of like character.

The new Constitution was carefully considered and properly passed upon, section by section, modifications made and finally approved as modified complete.

Technical papers were read as follows, and some elicited much instructive discussion:

1. Nickeling Direct on Zinc. Read by Mr. Allen (Editor).
2. One Phase of Nickeling Bumper Bars. By Mr. E. V. Allen, E. V. Allen Co., North Chicago, Ill.
3. Separation of Gold and Platinum. By Mr. Joseph Simpson.
4. Lacquer. By Mr. W. P. Hunter, Egyptian Lacquer Co.
5. The Relation of Anode and Cathode Efficiency. By Prof. O. P. Watts. Read by the Vice-President. An extremely valuable paper. Immediate publication requested.
6. Various Forms of Agitation in Hot Nickel Baths. By Mr. C. C. Martel.
7. Electro-Plating as Met with by the Analytic Chemist. Read by the author, Mr. F. C. Broeman, Consulting Chemist for The Corcoran-Victor Co., Cincinnati, makers of auto lights, etc. This developed into a very edifying and lengthy discussion as to the use of electric cleaners and sodium silicate, also the control of sodium carbonate accumulation in silver baths (without increasing the cyanide content) by the use of hydrated lime.

8. Conductivity of Nickel Solutions. Read by the author, Mr. L. D. Hammond, U. S. Bureau of Standards.
9. Moving pictures of American Rolling Mill Company.
10. Copper Plating for Carburizing. By Mr. Mader, N. C. R. Company.
11. The Acidity of Nickel Depositing Solution. By Mr. M. R. Thompson.
12. Effect of Impurities in Nickel Solutions. By Messrs. M. R. Thompson and C. T. Thomas.
13. Distribution of Nickel Deposits. By Mr. Graham.

In this paper the author gave data of great practical value, which he had accumulated from accurate scientific experiments covering a long period of work. On account of leaving on an early train, the author could not take part in very much of the animated discussion which followed.

On the whole the papers and discussions were so valuable that Mr. Gayling of Philadelphia, Pa., moved that the technical transactions of this convention be published immediately in book form and distributed to the members, regardless of the Monthly Review. It appeared, however, that the A. E. S. had insufficient funds to do this and the motion was lost.

The plant of the Corcoran-Victor Head Light Company was visited, also that of The Crane & Breed Company, undertakers' supplies.

The officers for the ensuing year were elected as follows:

W. J. Allen, President.

B. D. Aufderheid, Indianapolis, First Vice-President.

F. J. Hanlon, Secretary-Treasurer.

Philip Uhl, Past President.

F. C. Mesle, Editor.

The invitation to hold the next convention in Providence was unanimously accepted.

Inasmuch as the inspection of manufacturing plants is popular among the platers, it is the hope of the writer that future conventions in arranging the schedules will allot more time to this attractive feature.

WHAT THE BRANCHES ARE DOING

Connecticut Valley Branch

The Connecticut Valley Branch held its regular monthly meeting on Tuesday, July 11, at Hartford, Conn., with President Legate in the chair. One application for membership was received and was referred to the Board of Managers.

A letter from Mr. Charles H. Proctor was read, in which Mr. Proctor accepted our invitation to visit Hartford in the fall and address us.

Plans are being made for a joint outing to be held by the Waterbury and Connecticut Valley branches during August. The following members were appointed as a committee to make the necessary arrangements: Messrs. James A. Bagshaw, E. N. Miller, M. J. Connors, H. R. MacFadyen, E. M. Stephenson and Frank J. Clark.

Mr. George B. Hogaboom, who represented this branch at the Cin-

cinnati Convention, was present and gave us a full report of the work of the convention. He also read and discussed a paper on "The Effect of Copper, Zinc and Iron on Nickel Deposits," which was presented at the convention by Dr. Thompson of the Bureau of Standards. Mr. Hogaboom's talk was one of the best we have heard and kept everyone interested for an hour and a half.

New York Branch

The regular meetings of New York Branch were held on June 9 and June 25, President P. Morningstar presiding.

June 9 the officers elected May 26 were installed by Mr. T. Haddow.

Mr. Voss reported the progress of proposed booklet on plating compiled by the New York Branch laboratory committee to be available to members of the A. E. C. A summary of contents were read. The concensus of opinion was it would meet a long felt want.

The booklet deals with the identification of unknown salts in plating rooms, assay gallon analysis and many practical formulas for plating and coloring metals.

At the June 23 meeting the paper on the revision of the Constitution of the A. E. S. was thoroughly discussed.

Chicago Branch

The regular monthly meeting of Chicago Branch, A. E. S., was held July 8 with President W. G. Bolt in the chair and all officers occupying their respective stations.

We had a fine attendance and had two visitors, one from Detroit Branch, Mr. Eienstaedl, and one from St. Louis Branch, Mr. S. J. Kelsey, both of whom entered into the spirit of discussion.

The report of the delegates to the convention and the convention committee report were received and placed on file. Mr. Servis and Mr. Willmore added zest to these reports by giving impressions of educational feasts we received there, and both concurred in the idea of discussing each paper as it is published, with the aid of the attendants from Chicago to the convention for the benefit of those unable to attend.

Mr. Hazucha reported the result of the ball game between the East and West and stated that the West won a good game. Score, 17 to 13.

Votes of thanks to Dr. Watts, Mr. E. V. Allen, Mr. C. C. Martel and Mr. N. P. Hunter were given for their fine papers read at the convention, and the Secretary was instructed to send same to the above gentlemen at once.

Our President, Mr. W. G. Bott, is organizing a club for saving to go to Providence-Attleboro in 1923 and wants to go to the next convention at least forty strong, stopping at all points of interest to and from the convention, and consuming a full week, so has requested all the Chicago boys intending to go to get in line and start now.

The Librarian then took charge of the meeting and stated, starting next meeting, in addition to our Question Box, we will have a special subject to discuss, and the next one is "Cleaning of Steel and Die Cast Materials for Enameling, as written by Mr. Jacob Hay, Chicago Branch.

Bridgeport Branch

Our second annual outing was held at "The Farm," Bridgeport, Conn., on June 10th, and was pronounced a great success by the ninety-one members and their guests attending.

A very interesting program had been arranged by the committee, which consisted of a ball game between Harry C. Flanagan's old-timers and William G. Stratton's professionals; dancing, swimming, bowling and running races completed the sports.

The committee in charge was composed of George J. Karl, chairman; Frank Spaine, W. G. Stratton, William Flaherty, J. C. Oberender, John Rall and D. J. Fleming.

We wish to thank the Newark, New York, Connecticut Valley and Waterbury branches for their support.

Our regular monthly meeting was held on June 16th with President Slattery presiding. Messrs. Rice and Hogaboom of the Waterbury Branch were with us. Mr. Hogaboom brought a tentative copy of the Constitution, which was read and discussed by those present and later turned over to the delegates.

At our Friday night round table talk George Belle favored us with a very instructive discourse on the different finishes and brought some very good samples, which were passed around and discussed. It was a very pleasant evening and all present agreed same was well spent.

John C. Oberender will be the speaker of the evening at our next Round Table meeting.

We have a few copies of Dr. Stanley's "Talks to Platers" left and anyone desiring same may communicate with the Secretary.

Newark Branch

Our regular meeting was held on Friday evening, June 16, with thirteen members present and President O. J. Sizelove in the chair. After the routine of business was transacted the meeting was turned over to the Librarian, Mr. Edward Faint, who introduced Mr. L. M. Graham, the speaker of the evening, who gave an exceedingly interesting talk on "Nickel Deposition Under Various Conditions of the Electrolyte, Current Density, Etc.," being the recapitulation of a series of practical experiments. A vote of thanks was given Mr. Graham for his excellent talk. Adjourned at 10:50 P. M.

Our July 7th regular meeting was held at our meeting room, 17 Central Avenue, twelve members being present and five visitors. Mr. Louis Schulte of the Pittsburg Branch was a visitor and gave a talk on his experiences in the electro-deposition of metals in Belgium, France and England. Mr. Fred Gumm was reinstated as a member of Newark Branch. Our meetings will be held as usual during the summer months. Mr. H. H. Smith gave a detailed report of the Cincinnati Convention.

The laboratory class was formed and twelve members signed the petition, thus signifying their intention of becoming members of the class which will begin in the fall. Our President, Mr. Oliver J. Sizelove, will conduct the class. A discussion upon iron solutions, also brass solutions, took place with lively interest.

Meeting adjourned at 10:40 P. M.

ELECTED TO MEMBERSHIP

Hartford, Conn., Branch

Active, Mr. J. R. Kennedy.....39 Sterling St., Springfield, Mass.

Indianapolis Branch

William N. Henderson.....308 East North St., Kokomo, Ind.
Active, Arthur C. Lamb.....642 East Ohio St., Indianapolis, Ind.

Toronto Branch

J. J. Luck.....89 Edgemont Ave., Hamilton, Ont.
J. S. Cairns.....10 Wiltshire Ave., Toronto, Ont.
William Enshott

Chicago Branch

Associate, Carl P. Morgan.....1750 Byron St., Chicago, Ill.
Active, W. Charles White.....1131 N. State St., Chicago, Ill.
Active, J. Halman Hustig.....3833 Ward St., Chicago, Ill.

Philadelphia Branch

Associate, D. Jaques Benoliel.....2628 N. Marscher St., Philadelphia, Pa.

Cincinnati Branch

Honorary, Mr. J. F. Locke.....Fisher Place, Cincinnati, Ohio
Active, Henry Flanner.....5311 Globe Ave., Norwood, Ohio
Active, Fredric J. Beawer.....548 W. Liberty St., Cincinnati, Ohio
Active, Harry Coyle.....Erlanger, R. F. D. A2, Crescent Springs, Ky.
Active, Frank E. Popp.....5308 Carthage Ave., Norwood, Ohio

SUSPENDED

Newark Branch

Edward M. Ball.....99 Lakeside Ave., Newark, N. J.
Robert G. Ball.....475 Lakeside Ave., West Orange, N. J.
C. A. Field.....Rochester, N. Y.
Walter Gregory.....407 Forest Ave., Arlington, N. J.
H. G. Niemeyer.....28 Halstead St., East Orange, N. J.
Elroy A. Pearsall.....166 Watson Ave., Newark, N. J.
J. W. Rosenbaum.....79 Austin St., Newark, N. Y.

Indianapolis Branch

Frank McDonald.....615 LaGrange Ave., Indianapolis, Ind.

APPLICATIONS FOR MEMBERSHIP

Connecticut Valley Branch

Active, J. R. Kenedy.....39 Sterling St., Springfield, Mass.

St. Louis Branch

Resigned, L. L. Gaus.....2303 Clark Ave., St. Louis, Mo.

BRANCH DIRECTORY

BOSTON

Regular meetings are held second and fourth Thursdays of each month, at 8 p. m., at the American House, Boston. Secretary, A. W. Garrett, 37 Dorset St., Dorchester, Mass.

BRIDGEPORT

Meets third Friday of each month in its laboratory, 260 John St., Bridgeport, Conn. Secretary, Francis J. Spaine, 1323 N. Ave., Bridgeport, Conn.

CHICAGO

Meets second Saturday of each month, at 8 p. m., at the Hardware Club of Chicago, Room 1125. Secretary, F. J. Hanlon, 2921 George St., Chicago, Ill.

CINCINNATI

Meets on the first and third Friday of each month, at 1262 State Ave. Secretary, W. J. Husing, 729 McMakin Ave., Cincinnati, Ohio.

CLEVELAND

Meets last Saturday of each month at Hotel Winton. Secretary, B. F. McCormick, 2024 Wyandotte Ave., Lakewood, O.

CONNECTICUT VALLEY

Meets on the second Tuesday of each month at 202 Washington St., Hartford, Conn. Secretary, G. E. Vibberts, 31 Crown St., Hartford, Conn.

DAYTON

Meets first Saturday of each month at the Y. M. C. A., Dayton, Ohio. Secretary, C. Van Derau, 61 Bish Ave., Dayton, Ohio.

DETROIT

Meets first Friday of each month at the Board of Commerce, Lafayette and Sheldon, at 8 p. m. Secretary, O. H. Phelps, 951 Clay Ave., Detroit, Mich.

GRAND RAPIDS

Meets on the second Wednesday of each month at the Vocational High School, 129 Bostwick Ave., N.E. Secretary, J. Andrew Warner, 738 Fairview Ave., N.E., Grand Rapids, Mich.

INDIANAPOLIS

Meets the second Saturday of each month at Hotel Denison. Secretary, Louis Mertz, 1728 Union St., Indianapolis, Ind.

MILWAUKEE

Meets second and fourth Thursdays of each month at the West Side Bank Bldg. Secretary, R. Steuernagel, 1508 Concordia Ave., Milwaukee, Wis.

MONTREAL

Secretary, A. Geroux, 48 Craig West, Montreal, Quebec, Canada.

NEWARK

Meets first, third and fifth Fridays of each month at Forresters' Home, 20 Central Ave., Newark, N. J., at 8 p. m. Secretary, O. F. Carlson, 225 West Grand S , Rahway, N. J.

NEW YORK

Meets second and fourth Fridays of each month at the Broadway Central Hotel Parlors, New York City. Secretary, E. Haas, 75 Warner Ave., Elmhurst, L. I.

PHILADELPHIA

Meets first Friday of each month in the Harrison Laboratory Building, University of Pennsylvania, 34th and Spruce Sts. Secretary, P. Uhl, 2432 North 29th St., Philadelphia, Pa.

PITTSBURGH

Meets first Saturday of each month at 8 p. m., at United States Bureau of Mines Bldg., Forbes St. Secretary, S. E. Hedden, 227 Fifth St., Aspinwall, Pa.

PROVIDENCE-ATTLEBORO

Meets first and third Thursday of each month at 26 Custom House St., Room 16. Secretary, C. J. Poyton, 269 Ohio Ave., Providence, R. I.

READING

Meets on the second Tuesday of each month. Secretary, William M. Fisher, 654 Gordon St., Reading, Pa.

ROCHESTER

Meets every second and fourth Saturday of each month at the Hotel Seneca. Albert H. Doering, Secretary, 49 Cutler St., Rochester, N. Y.

SYRACUSE

Secretary, M. J. Crean, 109 Court St., Syracuse, N. Y.

ST. LOUIS

Meets first Tuesday of each month at Barr Branch Library, corner Jefferson and Lafayette Sts. Secretary, H. H. Williams, 4156 Botanical Ave., St. Louis, Mo.

TOLEDO

Meets first Thursday of each month at Toledo University Science Building, Electro-Platers' Room, corner Cherry and Page Sts. Secretary, H. L. Myers, 410 Palmer, Toledo, Ohio.

TORONTO

Meets second Thursday of each month at Occident Hall, Bathurst and Queen Sts. Secretary, E. S. Turner, 873 St. Clair Ave., Toronto, Ontario, Canada.

WATERBURY

Meets every second and fourth Friday of each month. Secretary, Wm. Delage, 47 Prospect St., Waterbury, Conn.